iM222A-ZNP (ZigBee Network Processor)

Datasheet Version 2.2

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1.0	Released version.
2.0	Modifications to document format and layout. Added chapter 4.3, 8, and 9.
2.1	Updated Table 3-1
2.2	FCC and IC statement added.

Aim of this Document

The aim of this document is to give a detailed product description including interfaces, features and performance of the radio module iM222A-ZNP.

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1 Summary / Introduction

The iM222A-ZNP is a compact, low power, bidirectional radio module for the 2.4 GHz frequency band. Using the iM222A-ZNP in an application minimizes the need for an expensive and time-consuming RF development. Fast time to market is possible with this module. With the integrated ZigBee Network Processor firmware[1] the iM222A-ZNP offers the opportunity to add full ZigBee PRO network support to an existing application via an easy to use serial interface. With less than 10 commands a complete ZigBee PRO network can be built and maintained without deep knowledge of the ZigBee stack.

Additionally the module has enough processing power to run an entire ZigBee application on top of the ZigBee Stack from Texas Instruments. IMST offers development support for any type of application on the basis of the iM222A, including different IEEE 802.15.4-based standards like 6LoWPAN, RF4CE and others.

This datasheet includes the hardware specifications and describes the features of the iM222A-ZNP as well as the possible RF settings. A brief instruction of the ZigBee features that come along with the ZigBee Network Processor firmware is given.

1.1 Key Features

- Complete ZigBee Ready module
- Output power up to 4.5 dBm
- Excellent Link budget of 101dBm
- Integrated antenna or 50 Ohm pad
- UART, SPI and Debug interface
- 256 kB Flash memory, 8 kB RAM
- 12-Bit ADC
- 128-Bit AES encryption engine
- ZigBee Network Processor firmware
- Mesh-, Clustertree-, Star-Networks
- AODV-, Many-To-One and Source-Routing
- Easy-to-use API over UART/SPI
- Bootloading support

1.2 Applications

- 2.4 GHz IEEE802.15.4 systems
- ZigBee PRO systems
- Low-Power wireless sensor networks
- RF remote control and RF4CE systems
- Smart Metering systems
- Home-, Building-, Industrial Automation
- Lighting systems
- Health Care
- Consumer Electronics
- …

Please visit our web site www.wireless-solutions.de for more information.

[1] Part of the Z-Stack available from Texas Instruments

2 Module Overview

The iM222A-ZNP is a small radio module for the 2.4 GHz frequency band. It provides a complete RF/MCU design including a transceiver, a microcontroller with AES coprocessor, a PCB antenna, and all necessary passive components as depicted in Figure 2-1. The iM222A-ZNP integrates a complete full feature ZigBee PRO stack with an easy to use API that is accessible either via UART (default) or via SPI.

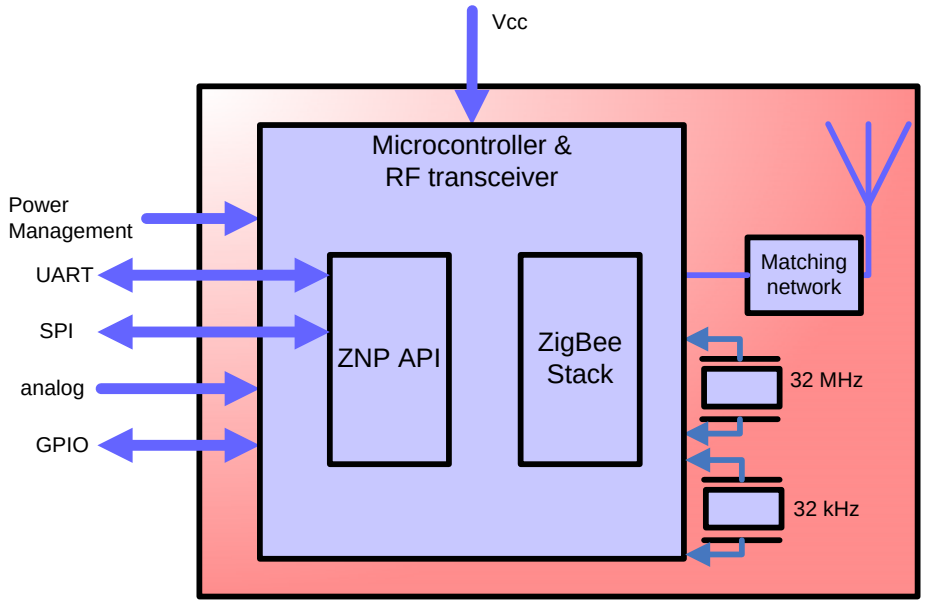

Figure 2-1: Block Diagram - iM222A-ZNP

The module runs the ZigBee Network Processor firmware from Texas Instruments. In addition to full ZigBee Device Object and ZigBee Application Framework API support, this firmware features a simple API that makes it possible to establish a ZigBee network with less than 10 commands. The firmware API can be easily tested by using TIs Z-TOOL pc software via TTL/USB bridge (included on WiMOD Demo Board). Low power consumption is achieved with an integrated low frequency crystal unit that enables sleep mode support for ZigBee end devices (this feature is only available when using SPI configuration).

Integrated bootloading functionality enables the user to make a firmware update over the UART interface. To use the bootloader an upload tool which is part of the Z-Stack package from TI (SBDemo) has to be used.

The module is solderable like a SMD-component and can easily be mounted on a simple carrier board with a minimum of required external connections. It is RoHS compliant and pre-qualified in accordance to ETSI EN 300 440-2 V1.4.1.

3 Specification

3.1 Absolute Maximum Ratings

Parameter	Range	Unit	Condition
Supply voltage	-0.3 to 3.9	V	
Input voltage	-0.3 to VCC +0.3	V	Any Digital pin
DC current	4	mA	Per digital pin
	20	mA	Only radio module pin 14 and pin 15
Operating temperature	-20 to +70	°C	
Storage temperature	-40 to +85	°C	

Table 3-1: Absolute Maximum Ratings

Note: Stress exceeding of one or more of the limiting values listed under "Absolute Maximum Ratings" may cause permanent damage to the radio module.

3.2 General Characteristics

T = 25°C, VDD = 3V (typ.) if nothing else stated

Parameter	Range	Unit	Condition
Operating supply voltage VCC	2.0 to 3.6	V	Typ. 3.0 V
Current consumption	typ. 24.3	mA	Receive mode
	typ. 28.5	mA	Transmit @ 0 dBm
	typ. 33.5	mA	Transmit @ max. RF output power
	typ. 3.4	mA	µC active, TRX off
	typ. 1	µA	Power mode 2, 32.768kHz crystal
	typ. 0.4	µA	Power mode 3
Dimension (L x W x H)	20 x 25 x 2.7	mm	±0.2mm
MCU operation frequency	32	MHz	
Real time oscillator frequency	32.768	kHz	
Memory (Flash)	256	KB	Minimum endurance: 1000 write/erase cycles.
Memory (RAM)	8	KB	

Table 3-2: General Characteristics

3.3 Module Interface Characteristics

T = 25°C, VDD = 3V (typ.) if nothing else stated

Parameter	Range	Unit	Condition
Digital output voltage	2.4 to VCC	V	High level
	GND to 0.5	V	Low level
Digital input voltage	2.5 to VCC	V	High level
	GND to 0.5	V	Low level
I/O pin pull-up/pull-down resistor	20	kΩ	
Pulse width on /RESET pin	min. 2.5	µs	Low active pin. See Note 1.
UART baud rate	typ. 115.2	kbps	
SPI baud rate	max. 4000	kbps	
ADC resolution	7 to 14	Bit	
ADC conversion time	20 to 132	µs	Depends on ADC resolution (68 µs @ 10 bit resolution)
ADC input resistance	197	kΩ	
Analog int. reference voltage	1.15	V	
Notes: 1) Shorter pulses may be recognized but will not lead to complete reset of all units within the module.			

Table 3-3: Module Interface Characteristics

Note: Additional to the reset pin the module has a Power-On-Reset (POR) functionality which holds the module in reset state until supply voltage increase above the POR threshold (rising edge). It will not work unless VCC has been below POR threshold (falling edge). See chapter 3.5 for additional information to the POR feature.

All radio module IOs except DIO_7 and DIO_8 are configured as input with pull-up resistor when a reset condition becomes active.

3.4 RF Characteristics

T = 25°C, VDD = 3V (typ.) if nothing else stated

Parameter	Range	Unit	Condition
Frequency range	2405 to 2480	MHz	16 IEEE 802.15.4 channels
Channel spacing	5	MHz	
RF data rate	250	kbps	
RF output power	max. +4.5	dBm	
RF output power range	-	dB	ZNP always uses maximum transmit power
RF sensitivity	typ. -97	dBm	1 % PER (Note 1)
Modulation techniques	O-QPSK		
Range	up to 500	m	Outdoor (line of sight) with external antenna (0 dBi) on pin ANT.
Notes: 1) PER = Packet Error Rate ; 20 bytes packet length.			

Table 3-4: RF Characteristics

3.5 Pinout Description

Figure 3-1 depicts the pinout of the iM222A-ZNP.

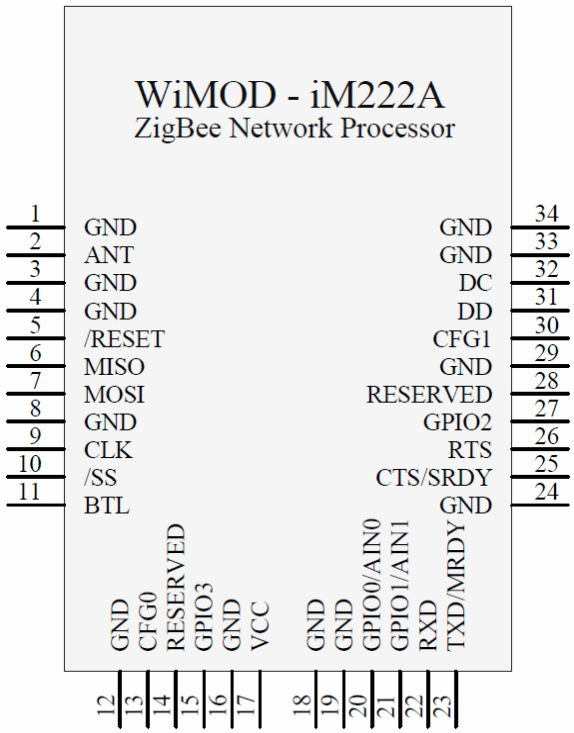

Figure 3-1: Pinout

Table 3-5 shows the mapping between iM222A-ZNP pin declarations and the CC2530 pin definitions as used in "CC2530ZNP Interface Specification.pdf" (SWRA312) from Texas Instruments. The pin functionality as well as their usage is described in the aforementioned document. Please note that the pin description in Table 3-5 reflects only the pin usage for the iM222A-ZNP (ZigBee PRO Network Processor). For a customized application with the iM222A-ZNP all peripheral features of the CC2530 can be used (see CC2530 datasheet).

Note: The POR functionality does not work correctly if the I/O-pins are connected to a second power supply while the radio module is powered up.

For example, if connecting the radio module to a host controller (e.g. RXD and TXD to another microcontroller) with separate power supply, it is strictly recommended to set all I/O-pins of this controller to high impedance or to GND potential when the radio module is powered down. If do not so, it is possible that the radio module is powered by the host controller over its I/O-pins with the result that the POR feature does not work correctly and the module status is undefined.

iM222A-ZNP PIN #	iM222A-ZNP Name	CC2530 Name	Description	PIN Type
1	GND	GND	Ground connection	Supply
2	ANT		Ext. antenna connection. Use only after consultation.	
3	GND	GND	Ground connection	Supply
4	GND	GND	Ground connection	Supply
5	/RESET	/RESET	Low active RESET input pin	
6	MISO	P1_7	SPI MISO – Master Input Slave Output	OUT
7	MOSI	P1_6	SPI MOSI – Master Output Slave Input	IN
8	GND	GND	Ground connection	Supply
9	CLK	P1_5	SPI CLK – Serial Clock	IN
10	/SS	P1_4	SPI SS – Slave Select (low active)	IN
11	BTL	P1_3	Low active bootloader pin[Note 2]	IN
12	GND	GND	Ground connection	Supply
13	CFG0	P1_2	CFG0, connect to VDD	IN
14	RESERVED	P1_1	Unused, do not connect	
15	GPIO3	P1_0	GPIO3 – configurable by software	IN/OUT
16	GND	GND	Ground connection	Supply
17	VCC	VCC	Supply voltage (typ. 3V)	Supply
18	GND	GND	Ground connection	Supply
19	GND	GND	Ground connection	Supply
20	GPIO0/AIN0	P0_0	GPIO0 / AIN0 – configurable by software	IN/OUT
21	GPIO1/AIN1	P0_1	GPIO1 / AIN1 – configurable by software	IN/OUT
22	RXD	P0_2	RXD (UART receive pin)	IN
23	TXD/MRDY	P0_3	TXD (UART transmit pin) / SPI MRDY	OUT/IN
24	GND	GND	Ground connection	Supply
25	CTS/SRDY	P0_4	CTS (UART CTS pin) / SPI SRDY	IN/OUT
26	RTS	P0_5	RTS (UART RTS pin)	OUT
27	GPIO2	P0_6	GPIO2 – configurable by software	IN/OUT
28	RESERVED	P0_7	Unused, do not connect	
29	GND	GND	Ground connection	Supply
30	CFG1	P2_0	CFG1, GND for UART, VDD for SPI transfer mode	IN
31	DD	P2_1	Debug Data (data line for programming and debugging)	IN/OUT
32	DC	P2_2	Debug Clock (clock line for programming and debugging)	IN
33	GND	GND	Ground connection	Supply
34	GND	GND	Ground connection	Supply

Notes:

1) In "CC2530ZNP Interface Specification.pdf" PAEN, EN and HGM pins are mentioned to control an external PA/LNA. This functionality is not available on iM222A-ZNP yet. The corresponding pins (depending on interface configuration) should be left open.
2) Set this pin to low level during/after a reset to switch into bootloader mode for a firmware update.

Table 3-5: Pinout iM222A-ZNP

3.6 Module Dimension

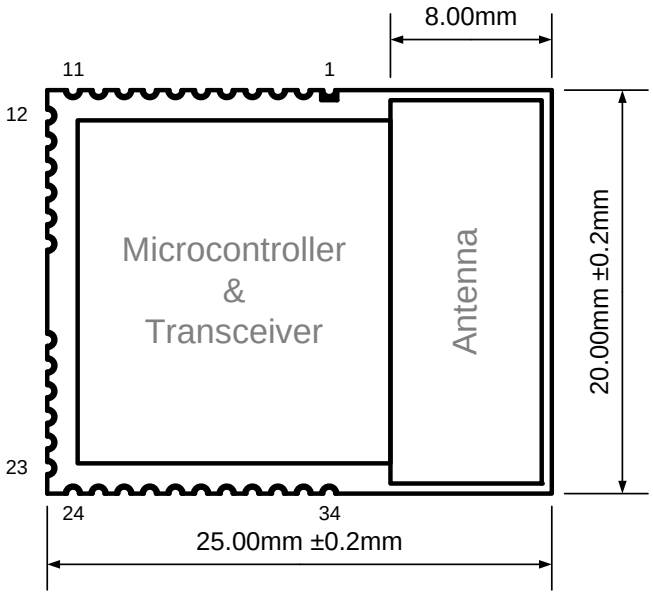

Figure 3-2: Module Dimension

3.7 Recommended Footprint

The pad pitch is 1.27mm.

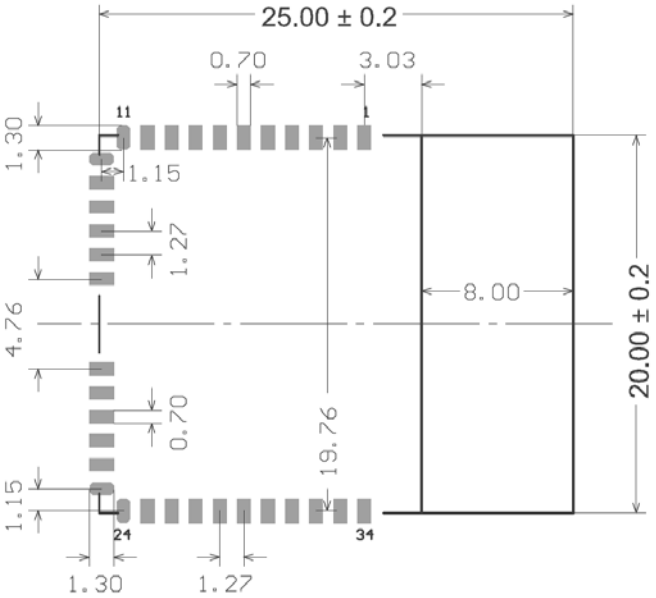

Figure 3-3: Footprint

All dimensions are in millimeters.

4 Integration Guide

4.1 Typical Application Schematic

Figure 4-1 shows a schematic of a typical application when using the iM222A-ZNP in UART (default) mode.

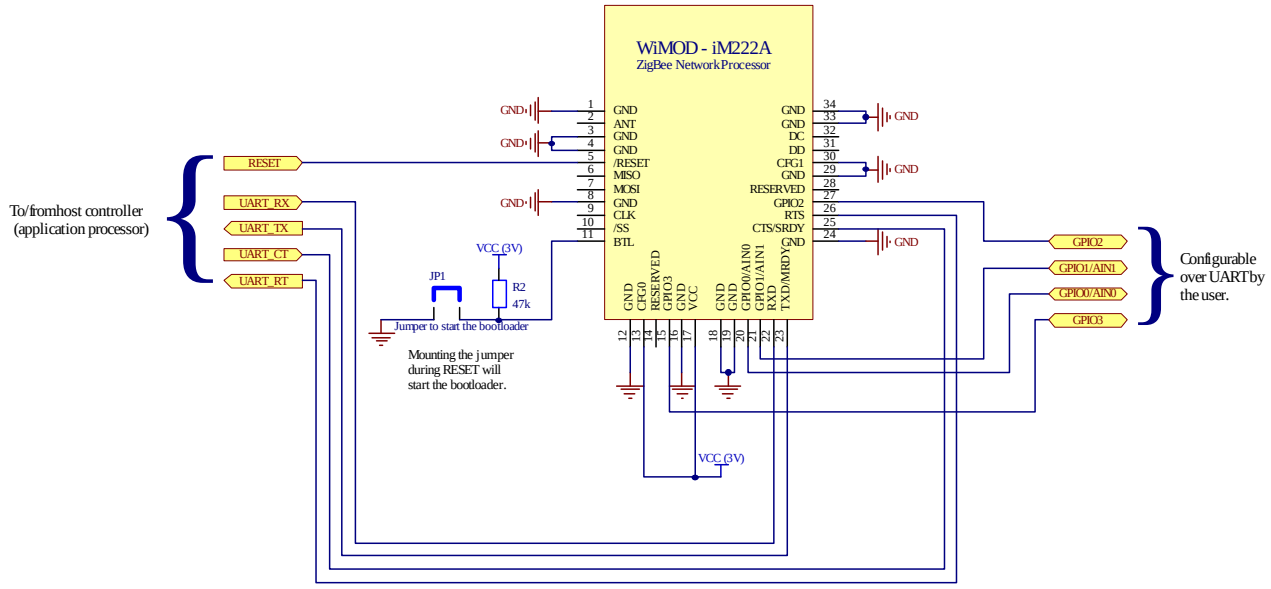

Figure 4-1: Sample application schematic using UART communication

Pin CFG1 must be set to logical zero to configure the iM222A-ZNP for UART mode operation and pin CFG0 must be set to logical one to indicate the presence of the iM222A-ZNP sleep crystal (32.768 kHz). Please note, that power-saving features are not available when using UART transport mode, for low-power operations the SPI transport mode is recommended.

The UART pins (TXD, RXD, CTS, RTS) can be connected to a host controller (application processor) or to a host PC (via level converter) for serial communication. In the latter case the Z-Tool can be used to configure the device. Optionally the RESET pin can be connected to the application processor to reset the iM222A-ZNP by this processor.

The pins GPIO0-3 are application specific and can be configured over the serial interface. It must be ensured that the maximum DC current per pin (see Table 3-1) is not exceeded.

> **Note:** Pin BTL has to be set to low level during/after a reset to switch into bootloader mode for a firmware update over the serial interface.

Figure 4-2 shows a schematic of a typical application when using the iM222A-ZNP in SPI mode (iM222A-ZNP = SPI slave).

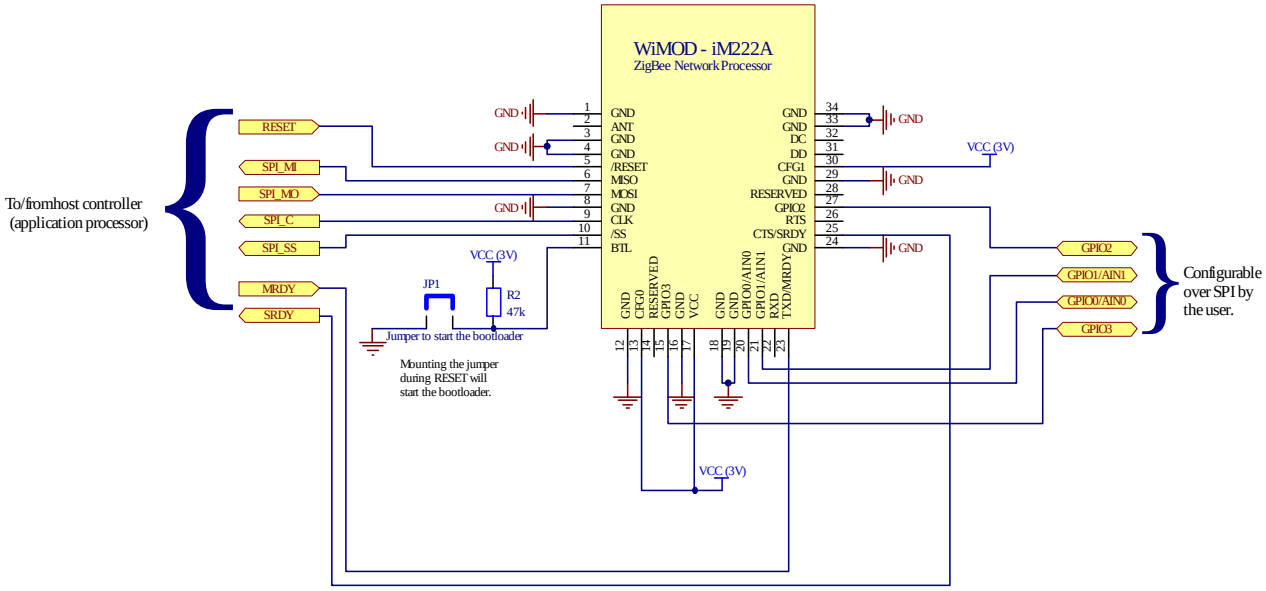

Figure 4-2: Sample application schematic using SPI communication

Pin CFG1 must be set to logical one to configure the iM222A-ZNP for SPI mode operation and pin CFG0 must be set to logical one to indicate the presence of the iM222A-ZNP sleep crystal (32.768 kHz).

The SPI pins (MISO, MOSI, CLK, /SS) have to be connected to host controller application processor for serial communication. Additionally pins MRDY and SRDY have to be connected to the application processor for SPI transaction control and power management. Optionally the RESET pin can be connected to the application processor to reset the iM222A-ZNP by this processor.

The pins GPIO0-3 are application specific and can be configured over the serial interface. It must be ensured that the maximum DC current per pin (see Table 3-1) is not exceeded.

> **Note:** Pin BTL has to be set to low level during/after a reset to switch into bootloader mode for a firmware update over the serial interface.

4.2 PCB Design Recommendation

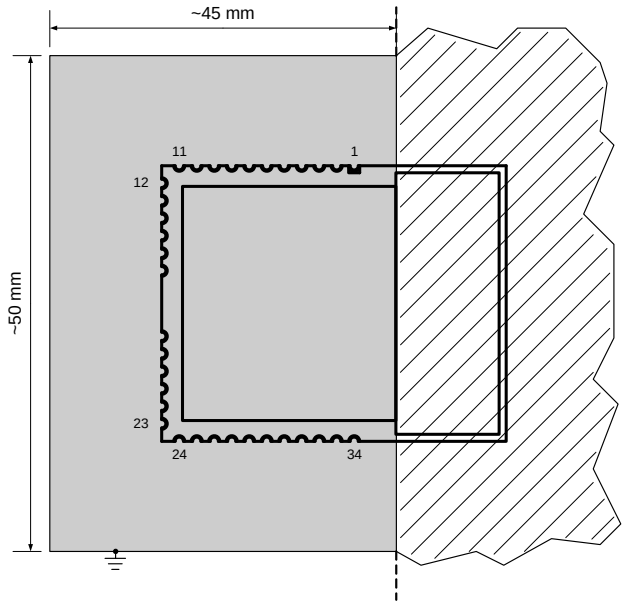

Figure 4-3: Recommended Environment

When designing a carrier board layout for the iM222A-ZNP the following design considerations are recommended:

- The Top Layer of the carrier board should be kept free of tracks and vias under the iM222A-ZNP because there are some testpads on the bottom side of the module which are not covered by solder resist.

- As shown in Figure 4-3, the solid grey area must be a ground-plane on the Bottom Layer (or Layer 2 in a multi-layer structure) of the carrier board. Antenna matching and all other measurements have been done with these dimensions.

  Info: Other dimensions can affect the RF performance respective RF output power, sensitivity, and unwanted emissions. Maybe the matching network of the integrated PCB antenna must be renewed.

- All radio module ground pads must be directly connected to the ground-plane by vias next to each ground pad.

- The hatched area shown in Figure 4-3 has to be free of material (e.g. PCB, metal, housing). If possible, the distance from the antenna area to any material should be at least $\lambda/2$ [see 1].

[1] At 2.4 GHz it is approximately 62.5 mm.

4.3 Recommended Soldering Conditions

An example of the temperature profile for the reflow soldering process of the iM222A-ZNP is depicted in Figure 4-4 with the corresponding values as given by Table 4-1. The temperature values should not exceed the limits.

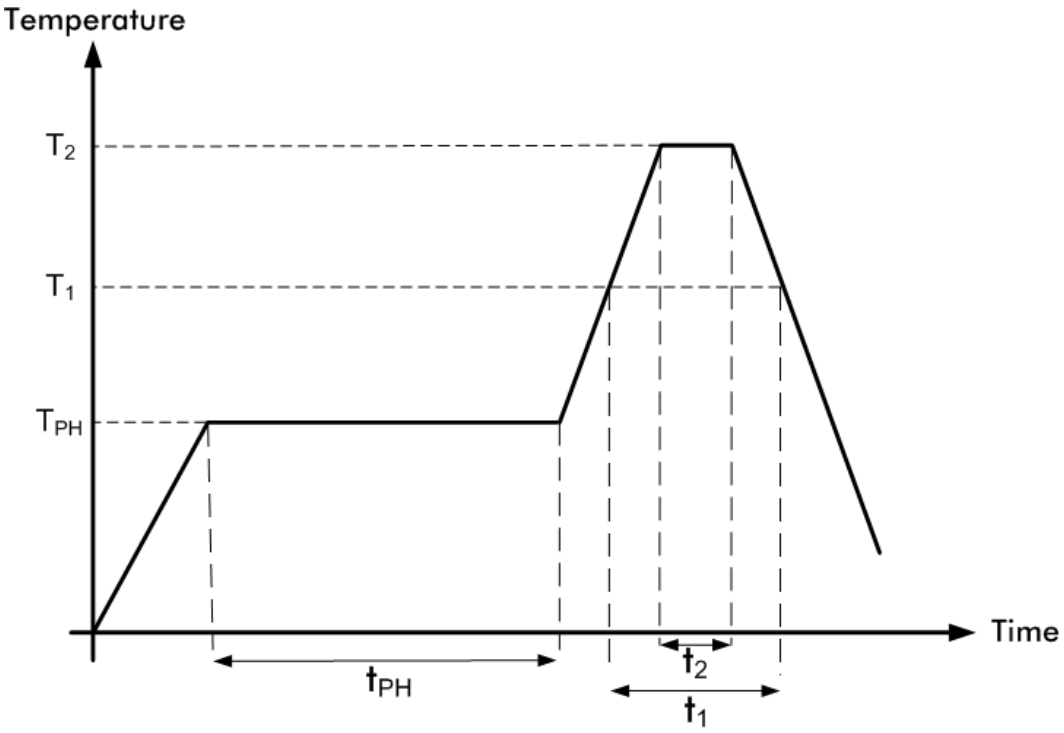

Figure 4-4: Recommended Solder Reflow Profile

Phase	Pb-Free Conditions
Preheating	t_{PH} = 120s T_{PH} = 160~180°C
Primary heat	t_1 = 60s T_1 = 220°C
Peak	t_2 = 10s (max) T_2 = 255°C

Table 4-1: Recommended Soldering Parameter for Temperature and Timing

Note: The quality of the soldering process depends on several parameters, e.g. soldering paste, carrier board design, fabrication equipment,...

5 ZigBee Features

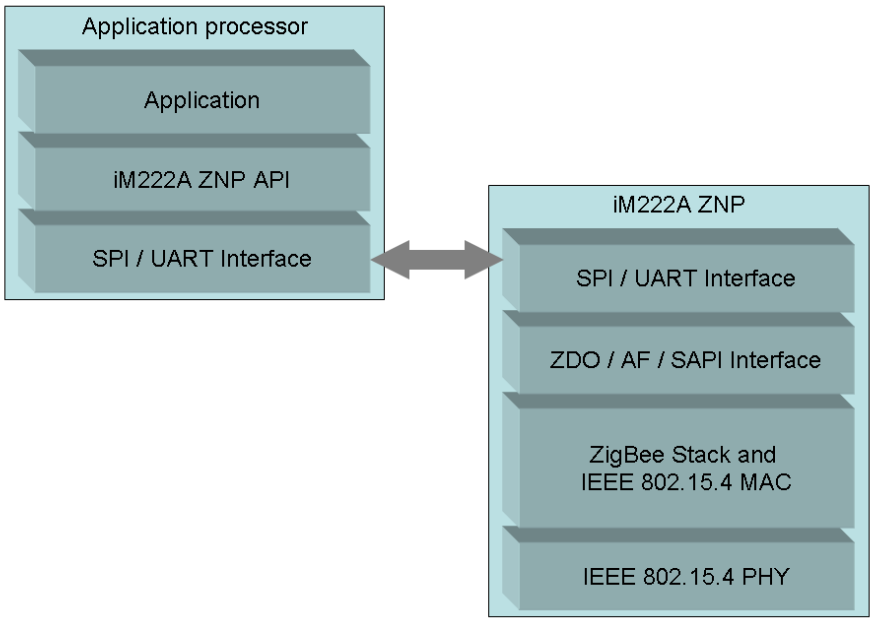

Figure 5-1: iM222A ZNP Stack overview

The iM222A-ZNP integrates a full ZigBee protocol stack including PHY, MAC and NWK but does not include high level ZigBee applications. The ZigBee application has to be implemented on the host processor and registers itself only to the ZigBee processor of the iM222A-ZNP to obtain access to the ZigBee functionality. The application does not necessarily need to be a ZigBee certified product. It is also possible to use the Simple Application Interface to benefit of the ZigBee routing and networking features without taking care on ZigBee conformance.

It is recommended to check the stack/protocol version and the actual documentation version number. This can be achieved directly after the power up, the SYS_RESET_IND should have been received, of the iM222A-ZNP by issuing the SYS_VERSION command (see p. 20 SWRA312).

5.1 iM222A-ZNP Software Command Interface

The complete application interface is described in the document "CC2530ZNP Interface Specification.pdf" (SWRA312) from Texas Instruments.

1. SYS interface

   Commands to get and set hardware specific parameters like local ADC readings, GPIO functions and non-volatile memory instructions.

2. Configuration interface

Read and write device specific parameters like operating frequency channel, security keys and descriptors.

3. Simple API interface

   Easy to use API that is registered as a specific ZigBee application endpoint. This can be used for fast bindings and data exchange without long initialization and registration procedures.

4. AF interface

   The application framework enables full ZigBee cluster and endpoint registration as well as source routing data requests and inter pan communication.

5. ZDO interface

   The ZigBee device object interface offers network discovery and maintenance functionality.

6. UTIL interface

   This interface offers some useful commands that are not mapped within the ZDO and AF interface (e.g. a one shot Poll request on MAC layer).

5.2 Additional Documents

These documents give an overview of the possibilities of the iM222A-ZNP. The first document specifies the complete physical and software interface of the device. This document has to be read before beginning the hardware/software design of the iM222A-ZNP.

1. CC2530ZNP Interface Specification.pdf (SWRA312), Texas Instruments

2. Creating a ZigBee® Smart Energy Device with the MSP430F54xx and the CC2530-ZNP (slyy022.pdf), Texas Instruments

3. ZCL API document (SWRA197), Texas Instruments

4. Examples on how to use the ZNP interface on a host processor (http://processors.wiki.ti.com/index.php/Tutorial_on_the_Examples), Texas Instruments

5. Example software for TIs CC2530 ZDK ZNP Mini Kit (http://focus.ti.com/docs/toolsw/folders/print/cc2530zdk-znp-mini.html, Texas Instruments

6. CC2530 datasheet (CC2530.pdf), Texas Instruments

7. Z-Stack package (http://focus.ti.com/docs/toolsw/folders/print/z-stack.html), Texas Instruments

6 Packaging Information

6.1 Carrier Tape Information

All dimensions are in millimeters.

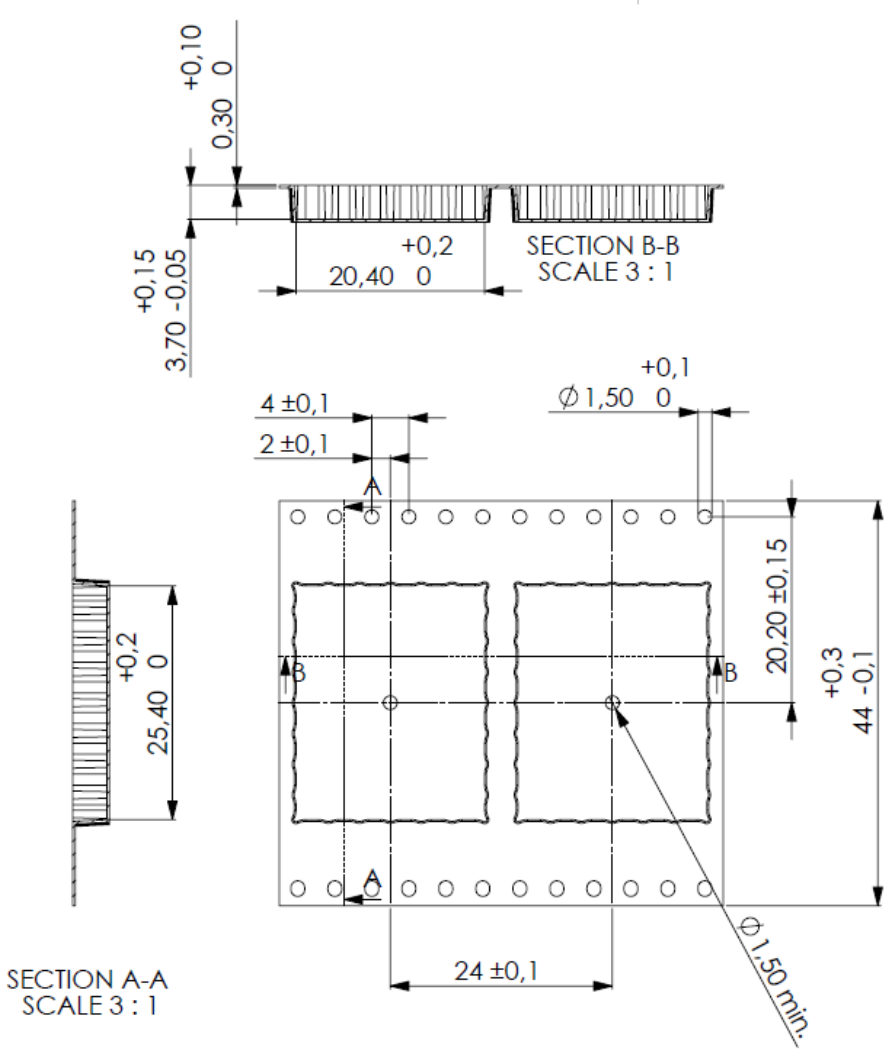

Figure 6-1: Dimensions of the iM222A-ZNP Carrier Tape

6.2 Reel Information

Reel diameter	Core diameter	Core width	Units per reel
330mm	100mm	approx. 45mm	max. 700

Table 2: Reel Information

7 Ordering Information

Ordering Part Number	Description	Distributor
iM222A-ZNP	Radio module iM222A-ZNP	wimod@imst.de
Notes:		

Table 7-1: Ordering Information

8 Appendix

8.1 List of Abbreviations

AB = Adapter Board
ADC = Analog-to-Digital Converter
AES = Advanced Encryption Standard
DIO = Digital Input/Output
E.I.R.P. = Equivalent Isotropic Radiated Power
O-QPSK = Offset Quadrature Phase Shift Keying
GPIO = General Purpose Input/Output
MCU = Microcontroller Unit
PCB = Printed Circuit Board
PER = Packet Error Rate
RAM = Random Access Memory
RF = Radio Frequency
RSSI = Received Signal Strength Indication
SPI = Serial Peripheral Interface
UART = Universal Asynchronous Receiver/Transmitter
USB = Universal Serial Bus
ZNP = ZigBee Network Processor
API = Application Programming Interface
ZNP = ZigBee Network Processor
ZDO = ZigBee Device Object
AF = Application Framework

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8.4 References

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9 Regulatory Compliance Information

R&TTE

The use of radio frequencies is limited by national regulations. The radio module has been designed to comply with the European Union's R&TTE (Radio & Telecommunications Terminal Equipment) directive 1999/5/EC and can be used free of charge within the European Union. Nevertheless, restrictions in terms of maximum allowed RF power or duty cycle may apply.

The radio module has been designed to be embedded into other products (referred as "final products"). According to the R&TTE directive, the declaration of compliance with essential requirements of the R&TTE directive is within the responsibility of the manufacturer of the final product. A declaration of conformity for the radio module is available from IMST GmbH on request.

FCC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device my not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. (FCC Part 15.19).

Warning: Changes or modifications made to this equipment not expressly approved by IMST GmbH may void the FCC authorization to operate this equipment. (FCC Part 15.21)

IC

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.(RSS-GEN)

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1)

l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement. (RSS-GEN).

The applicable regulation requirements are subject to change. IMST GmbH does not take any responsibility for the correctness and accuracy of the aforementioned information. National laws and regulations, as well as their interpretation can vary with the country. In case of uncertainty, it is recommended to contact either IMST's accredited Test Center or to consult the local authorities of the relevant countries.

10 Important Notice

10.1 Disclaimer

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